

Klamath Network Cave Vital Sign Scoping Meeting

October 20-21, 2008

Meeting Notes

Day 1 - Morning Session

1. The Meeting started with Dennis going over his presentation on the past scoping efforts the Network has been involved with emphasis on the 2006 conference call.
2. After the presentations, there was a general discussion on a few basic topics about some of the things that need to be considered prior to developing the protocol.
 - a. There was a discussion on the need to sample both abiotic and biotic resources. John stressed that monitoring needs to integrate biotic and abiotic and that the abiotic parameters should be used to interpret the biotic measurements. It was determined that best efforts should be made to do both, however if funding was a limited issues then this topic could be revisited. Daniel suggested that abiotic and biotic crew be same. Shane replied that most of abiotic would probably be data loggers.
 - b. Funding is a major issue and there need for some clarification on how much is available. Daniel and Sean thought there was 30k but the monitoring plan listed 50k. Daniel will check on this and let Jean know the total amount of funding the network could commit.
 - c. Daniel stressed the importance of sticking to the budget (and that the amount is likely to be closer to 30K); and that tasks should be done in collaboration with parks. Budget may help define questions, such as instrumentation, and seasonality. This indicates a need to discuss the resources available in parks for monitoring (e.g. seasonal employees), raises possibility of a KLMN staff collecting data, and employee Jean or similar to periodically analyze data. It was clarified that the 30-50k is what the network could afford and does not include park resources (park funded staff time, park equipment, etc).
 - d. There was some discussion on measuring the various gradients associated with caves (light zone to dark zone).
 - i. Dave Larson mentioned if we have to chose, dark zone is better to monitor. It is less variable.
 - e. Dennis mentioned the possibility of using the crew from the vegetation monitoring effort to measure more sites but Daniel put the kibosh on the idea.
 - f. Shane discussed the need for some protocols even if the Network determines they cannot monitor a parameter desired by the park. The park staff has implemented various methods over the years but there is not a solid scientific design, consistency, etc associated with this effort. However, as Dave Larson mentioned for some of the methods the parks have been using them for long periods of time (such as bat monitoring) and would not want to turn their backs on those methods without a more

detailed discussion. It was determined that this is something Zara environmental could determine.

- g. John Roth mentioned the need to conduct some baseline inventories prior to implementing the monitoring. He felt we would need this info to support the protocol.
3. Based on the limited funding available, there was a discussion on the best methods to get the most information for the limited amount of funding. The park staff determined they could commit some staff time to help implement the protocol.
- a. LABE currently spends ~8 hours a week on conducting cave monitoring and could commit this time to helping the network implement their protocol. Felt they could commit 1-1.5 fte. But this included their work; it would be more like 0.4 fte to help with I&M protocol.
 - b. ORCA currently commits 1 fte which could be used to help implement the network's protocol. However, if the expansion of the monument becomes a reality the amount of staff availability will go down.
 - c. It was determined that as we begin to develop the protocol, we need to determine what projects the park staff can do without network help and what project the KLMN can do either alone or while working with the parks. Daniel suggested one approach would be to have the park staff conduct most of the field work and then send the data to the Network for analysis and storage. Everyone agreed there was room to build on this idea but the details will need to be figured out and clearly defined in the protocol.
 - d. Shane pointed out that they often have multiple people doing a variety of task at each cave for safety and logistic reasons. For safety reasons, there may be the need for a 2 person field crew. Sean mentioned that if this is not possible then a solid communication plan should be developed.
 - e. Both parks said there is a good chance that housing would be available for 1 or 2 people but we would have to pay the housing fee.
 - f. In terms of hiring, SCA's are getting expensive and we may be better off hiring a GS-4 or GS-5 employee. We could also pay part of the salary of the park staff but they would need to have the I&M associated task listed in the performance evaluation.
 - g. Daniel suggested that there are a variety of scenarios on how to monitor the caves, budget, what parameter to monitor, and who would do the monitor. So we should look at a variety of options. Sean and Jean mentioned this was already included in the contract.
 - h. John stated that there are two things NOT available from the park: 1) Analysis of current inventory that already exists (and he stressed importance of using this data to develop a sound monitoring plan). Daniel thought that this might be possible with end-of-year \$, but need a critical project statement. Sean stressed the importance of writing up these projects so when yearend money is available (such as the previous year) we could look at getting some of these completed. 2) A lot of work is

being done by the parks and we need to see if their protocols are good or if they can be adjusted.

- i. John mentioned the importance of giving lots of thought to logistics. The time to get to and in caves is not to be underestimated. Suggests importance of combining as many of the sampling method as possible at the same caves.
 - j. Dennis brought up the concern about the stability of park base funding and insuring the staff will be available to help with the protocol. Dave mentioned they are currently turning a seasonal position into a term position to help with the bat monitoring.
 - k. Daniel wanted to make certain if we incorporated work the park is currently doing into this protocol that it meets the objectives outlined for the network vital sign. John had no problem helping with the monitoring but needs Jean to determine a robust design that will cost x & y hours of work.
 - l. John wanted to revisit the objectives, and suggested that there not be an emphasis on “showcase” versus unmanaged caves. Really, the best design would be monitoring one cave, and having a gradient of use within that single cave, (introduced the idea of a perpendicular gradient from cave trails).
 - m. The basic consensus forming: KLMN and JK design much of SOP, but parks are the “boots on the ground” Shane also mentioned LABE has volunteers that they could use.
4. There was some discussion on the gradients of cave monitoring.
- a. Gradient influences on monitoring design – all agree on inferring on a range of conditions, but that \$ may be a challenge. Dave stated that a focus (if necessary?) on Dark Zone would be better for LABE. John agreed for ORCA, stated that biodiversity at cave entrance fluctuates too much for good baseline study.
 - b. Daniel asked if gradients were consistent and probabilistic, i.e. are patterns consistent across caves? Jean replied, yes, generally. However, problem of unique cave morphology creates large differences (e.g. pit entrances, streams, narrow entrance, chimney effects, etc.) Daniel said this might necessitate cutting out some of the rare habitats, just not enough to get adequate sample sizes – referred to work of previous NPS statisticians – w/o sample size, just not worth sampling. Thought to power needs to be considered.
5. There was a short discussion on some of the reports
- a. Daniel mentioned that we need to work with Jean and the park staff to determine what kind of summaries we will want to include in the annual reports. Since Daniel will be the project lead it will be his responsibility to complete these reports. Jean thought a lot of the analysis and reporting could be done in-house.
 - b. For the Analysis and Synthesis reports, because of time limitations and lack of cave expertise among network staff we will need to get help via partnerships and contracts with cooperators.

- c. It was recognized that if we need to use outside expertise to complete the A&S reports this could be an added cost. It was determined that we should setup partnerships and agreements early so we can use network and park year-end funding to complete some of these analysis.
- d. Jean mentioned the synthesis reports are largely a review to make sure that the data is meeting the initial objectives? But the techniques will already be vetted, so focus may be on putting the cave study in context of other caves, plus some effort spent on determining whether or not we can tweak the protocols. Dave liked the idea of trying to ensure the cave monitoring contributed to the world literature.
- e. John wanted to note that all the data does not need to be used in the synthesis reports. Sean responded that this is true; however we need to define the analysis that we are going to do in the protocol so it should be clear which data will contribute to which analysis in a given year.
- f.
- 6. There was a short discussion about the monitoring objectives.
 - a. John brought up the fact that objective # 1 has a research component too it was we would need to compare caves. He felt we should get rid of this aspect of the objective. Daniel agreed.
- 7. There was a small discussion on the design of the protocol.
 - a. The park staff made it clear that they are in need of a feasible protocol that is statistically and scientifically based. By “Protocol” they were talking about the sampling methods for each parameter we plan on measuring.
 - b. The question came up, if we are not going to monitor a parameter using KLMN funding, but the parks still want a protocol for that parameter, should Jean spend her time writing that protocol. There was no final answer but Sean did mention the first priority should be for Jean to complete the work for the parameters we plan on monitoring. If there is extra time, perhaps we can have her complete some additional protocols.
 - c. Dave brought up the Hobo project at LABE where they have been putting HOBOs out for a variety of different reasons and finally decided to pull them because they did not have a good game plan on how to use the HOBO. If Zara Env. Comes up with a protocol they could then implement this portion of the protocol on their own.
- 8. Prior to lunch, Sean gave a presentation on the methods the network uses to work with parks staff and contractors to develop a protocol. He also provided a handout of the 20-step process the network follows.

Day 1 - Afternoon Session

- 9. To start the afternoon session we began by having the parks give a presentation on what they currently doing to monitor, inventory or study cave environments in their parks.
 - a. Shane (LABE) gave a presentation on the current work being done in the parks. Some of the information he presented is listed below
 - i. Currently 777 caves defined in the park

- ii. 28 are heavily visited and 20 are lightly visited. The other caves are managed for habitat
- iii. 85% of the people that visit the monument are there to see the caves with equates to ~85,000 visitors using the caves.
- iv. The caves are managed for a variety of things including:
 - 1. Visitation- track pads checked every Monday; infrared sensors can be checked once a month. Currently monitoring 11 caves.
 - 2. Invertebrates - many obligate cave species, and diverse. They have inventories, but no monitoring. Springtails will hop in pools, but no aquatic invertebrates. They feel that the Collembola may be the best invert to monitor. Jean mentioned the problem with inverts is that in dark, deep zones sampling will result in many zeros. Inverts have a sparsely dispersed, clumped distribution.
 - 3. Bats resources: 15 species in area, 13 in LABE, 4 or so are cave obligates. Monitor outflights, photo estimations, simple counts. Colonies range in size from 125 to 250 thousand. 22 years of data on some aspects. Time is coming to do new summary (which is done every 4 -5 years). Interested in having Fish and Game from Missouri in using IR for estimates – one biologist suggested he/she could come out with IR gear to field test and compare #s.
 - 4. Some amphibians in caves, but not a big concern.
 - 5. Ice is one of the parks major concerns; they have several caves with ice that is disappearing at a fast rate. They have done some monitoring but would like to have a protocol developed to do this even if it does not become part of the network monitoring protocol. They have lost 80% of ice resources. Going to do radio dating with Dr. Miller from OSU. Caves with ice are at 32 degrees – buffers entire cave temperature. With ice loss, they expect to see huge shifts in cave temps. Also interested in behavioral dependence of inverts on ice (temp. cues?). Dave gave an example of ice as a lost resource, ice in the cave called “frozen river” now is gone in only 2 years. We discussed the potential of doing a comparative study between caves with and without ice but there were several difficulties with this type of project and it was not considered a monitoring question but more of a research question. Back in 2005, some ephemeral ice features formed directly related to a wet year. Of the ice caves, only Skull cave has gained ice in recent years – which coincide with dumping of 10,000 gallons of water for washing of cave. Suggests that ice features could be rebuilt. Water table is 760 ft down.

6. Pika was mentioned but it is thought they do not use much of the caves and a rarely seen at the entrance to caves. There is not current pika work being conducted in the parks.
- v. Park staff mentioned they have used citizen science in the past to help get their work complete. Daniel mentioned the role citizen science has played in some networks but did not want to include this option as part of the protocol.
- vi. Photo monitoring, either annual or every 5 years. They've had difficulty (e.g. different flashes, cameras, etc.) No quantifiable data from photos. Might work as "time capsule" but unsure of use as monitoring tool. But no harm, relatively easy? So they have continued. Has worked well for documenting ice loss. Have photos in Crystal ice cave back to 82 or 83.
- vii. They do have some cultural resources they are concerned with losing to moss and weathering. This was considered a management issue and not sure what monitoring would tell them.
- viii. There have been several inventories / monitoring done on climatic factors.
 1. Temps – temp stability only seen in deep sections of cave. Have tried to set up region wide monitoring using HOBOs with climatologists and statisticians – but this is proving to be really, really hard.
 2. LABE has seen approximate 60 day lag in temperatures for Crystal Cave, but water and other cave unknown.
- ix. The park is also concerned with influences from outside of the cave. A few that were mentioned included:
 1. Roads over top of caves and some buildings as well. They are interested in maintaining surface structures without damage to caves.
 2. LABE also has substantial trail infrastructure. Hope that monitoring will help tease out visitor effects from climate change effects. Some caves are completely impacted.
 3. Burns will be occurring over the top of caves.
- x. The park has done a good job documenting the location and type of caves they have.
 1. 777 caves with inventory forms on ~400 of them.
 2. They have begun to limit mapping due to disturbance caused by the effort. They are looking into OSU hydrogeography crew to help with some of this effort.
 3. They have some restoration efforts in the works.
- b. Elizabeth (ORCA) provided a spreadsheet of the variety of projects that have been completed at ORCA. Some of them included.
 - i. Use of hobo's to look at the microclimate, airflow, relative humidity, radon, stream parameters, pool parameters, soda straw,

marble dissolution and calcite, bat, invertebrates, lint, and fungi.

See handout for a complete list.

- ii. Some of the concerns ORCA had that they would like to learn more about included:
 - 1. Dropped conductivity because of little variance
 - 2. Dropped darkening of cave walls because could not figure out how to monitor
 - 3. ~10 sites, floor – person – and ceiling sight
 - 4. Gap in air flow information, need it for water budget.
Problem is people moving in the cave changes the airflow
 - 5. 50% of cave is accessible, track each person
- iii. Vast majority of monitoring is in Oregon Cave, very little – none in smaller caves.
- iv. John had a strong emphasis on the need to understand the variety of components that help develop the water budget (air flow, filtration, etc). However, it was recognized this would be a very intensive study to look at all these components.
- v. Jean summarized the ORCA efforts as many short-term research questions with some frustrations by park staff with the analysis (or lack of analysis). Jean wanted the park to let her know what they felt was important or not important.

Day 1 - After Break

- 10. Some general questions were discussed after the break to make certain we were all in agreement in preparation for more detailed discussions on the following day. Some things discussed were
 - a. Daniel was wondering how important is it we find common ground between two parks.
 - i. Determined the more common the methods the easier it will be when it comes to training, database, analysis, etc.
 - ii. It was recognized this will not always be feasible but should be done when we can
 - iii. John thought we could use the same design for macroinvertebrates and ice.
 - iv. Daniel thought climate and physical parameters are something that can be done in a similar manner. Everyone agreed RH, airflow, and temp are important.
 - v. John recommended we change ice to water since each park will then have a water component
 - vi. There was some difference in opinion on the importance of the microbial and macroinvertebrate information. Jean mentioned the difficulties with monitoring macroinvertebrates (analysis, inventory, etc).
 - vii. John mentioned the sampling frame and replication could be different for each park but the protocols could be the same.

11. Earlier in the year LABE had a meeting where they listed and ranked a variety of parameters associated with cave monitoring that they felt were important for a variety of reasons (see handout). We decided to go over the list on page 2 of the handout to see if everyone was in agreement on what is / is not important or feasible to monitor. Abiotic factors were:
- a. RH / Temp – Highly important
 - b. Air movement (temp sensors can pick this up if drastic changes). Jean not sure if it would change any management patterns. Daniel thought it could be done as an inventory. John's main interest with this was to help establish a water budget. It was thought this may be a good inventory project but does not need to be done every year.
 - c. Ice Resources – The visible ice is already monitored but the methods are difficult and vary quite a bit. Daniel mentioned that if we are seeing continued loss so what to do?
 - i. It was mentioned that 2 things that influence ice in caves is precip and temp. If no precip in late spring but comes in summer there is usually no ice (in some, not all caves).
 - ii. Need to think about a method to quantify the ice, questions with sonar and lidar were discussed but it did not seem like a feasible option.
 - iii. Daniel thought we could use some of the ice caves as judgment sites. Currently 15-30 caves with some ice depth.
 - d. Hydrology / Aquifer / Quantity / Pools – flowing water at ORCA was originally dropped out during the initial scoping meeting. We need to check on why it was dropped out but the recollection is that this would be included in the Water Quality monitoring protocol. It was determined Eric can add this component into the water quality sampling as part of the aquatic monitoring.
 - i. John recommended it would be good to do water quality at drip buckets currently in the cave. They have 2 sites with 2 buckets per site. He feels for ORCA hydrology / pools / discharge is important.
 - e. Air Quality – Not feasible to measure
 - f. Lint and Dusting – parks talk a lot about this and there are ways to measure.
 - i. Dusting at LABE is where pumas were historically placed on the floor and this is a temporary problem. No real need to monitor.
 - ii. Lint can be difficult to monitor at ORCA because it is a moist cave and the lint decomposes pretty fast.
 - iii. Lint is also difficult to measure at LABE because it tends to fall into cracks and is hard to see and collect.
 - iv. Mammoth caves might have a protocol we could examine since they have done this type of work using Petri dishes.
 - g. Soil Chemistry / Surface – outside materials being dragged into the cave and if it changes then change the community of the cave. Felt this would

be hard to monitor. John did mention that organic activity was important in addition to the importance of lipids in the soil.

- h. Impacts to cave floors, surface polishing, and broken formation.
 - i. Daniel thought this was a management issue and may not need to be monitored.
 - ii. Jean felt cave floor impacts in a sediment situation was important but broken formation are not as important to monitor.
 - iii. John mentioned they looked at what the effects of compaction, trail use, and sediment movement on microbial population and found there is very little difference between effected and non-effected areas. The main effect on microbes was how wet the sediment was. Shane mentioned class one caves are all impacted but less used caves are more natural and might be more important to look at more natural caves to see if there are changes over time. Long term would be good to look at back country caves.
 - iv. Jean thought a possible substitute for class two caves would be to look at visitation as a supplement of monitoring for damage. Problem is it is usually a careless person or issues associated with monitoring.
 - v. Dave mentioned it would be helpful to the parks to have a protocol to monitor this even if it does not become part of the network monitoring protocol.
 - vi. Shane mentioned the park is now selling gloves and knee pads which means visitors will be going into areas they normally would not so you may see an increase in the number of broken formations.
 - vii. John talked about how they tried to monitor broken formations but because of the moisture in the cave they are not having success permanently marking the formations.
 - viii. Shane mentioned sometimes it can be difficult to assess the damage. For example, coroloids (?) are very fragile and it would be hard to determine what was damaged and what was natural.
 - ix. Determined we could put this in an alternate category because we may want to do it if it is feasible.
- i. Daniel mentioned calcite slabs for ORCA. John felt it was critical for them, they are monitoring the calcite slabs in the park and they want to make sure the calcite data derived from the water quality monitoring corresponds with the data from the slap monitoring. Park does the slap, we do the water quality, but this may increase the cost to do them. Eric recommended doing a pilot study at ORCA to test variability. Determined this could be an alternate measure based on cost.

12. Biotic factors included:

- a. Crossed out amphibians, birds, (think about presence or martin and owl)
- b. Vegetation – variation around the entrance is very high, ferns are a key plant in the area, and several management factors may affect the resource.

Class 1 caves have very different vegetation versus other class caves. Non-vascular done as percent cover, need to figure out the zone of influence.

- c. Rodents
 - i. Shane stated they are a high energy input into the caves, varies depending on the cave, very hit and miss
 - ii. John mentioned they are easy to monitor
 - iii. Sean suggested looking into the protocol already developed from Mammoth cave
 - iv. Daniel suggested doing a carbon input analysis (scat)
- d. Bats
 - i. Everyone agreed bats were important for legal and management mandates but Daniel wanted to make certain that they “fit” into the vital signs model.
 - ii. Shane also wanted to make certain wood rats were not overlooked because we tend to focus on bats.
- e. Invertebrates
 - i. Jean – hard to analyze, distribution makes them hard to search and analyze, island of productivity, locations change through time. Can use attractants but run into the same issue, probably better to use the attractants. ATBI survey could be done. Time constrained searches.
 - ii. Observer bias associated with this so it should be used in combination with various methods.
 - iii. Jason – back versus front of cave important.
 - iv. Daniel wondered what can you do long term as a manager to help invertebrates?
 - v. Jean better to focus on bats and rodents or put a lot of emphasis. Lots of noise and not much of a signal.
- f. Microbes
 - i. John feels they are very important for carbon budget, geological and biological. Made case to do a BOD next to the trail, away from the trail, and at the cave entrance. Thinks you can get a lot of information in a simplistic manner at least for the baseline.
 - ii. ORCA also has a sampling effort in multiple pools for multiple days. Daniel mentioned he can see the value of this but wonders how you develop a sampling design to monitor this parameter. John thought running a BOD is not that big of deal. BOD means biological oxygen demand. Would need to be done 4 times a year. Daniel – issues with dilution, variability, etc. John – with the exception of the bat caves, this is probably the biggest support for the macroinvertebrates. Daniel – there may be a functional element to this protocol because a majority of the life inside the caves has its energy provided by outside sources.

13. After detailed discussions of each parameter we were able to come up with the following list

- a. Abiotic parameters

- i. Climate (RH, temp, other parameters)
 - ii. Ice (Photograph, measure from ceiling)
 - iii. Lint & Dust (Petri dish)
 - iv. Visitation (Counters and logs)
 - v. Alternatives
 - 1. Impacts to floors
 - 2. Broken formations
- b. Biotic Parameters
 - i. Plants (vascular spp & non vascular by % cover)
 - ii. Bats
 - iii. Rodents (woodrat and other scat)
 - iv. Macro Invert
 - v. Alternatives
 - 1. Microbes (BOD is pools and Soil)

Day 2 – Morning Session

The general discussion for the day included: logistics, sampling frames, and the levels of change and how they relate to management action.

1. There were some miscellaneous discussions to start off the day.
 - a. Jean opened the discussion with the question of how should the data detect significant change? Dennis responded by discussing trigger points as a way to help inform management. Shane thought the thresholds identified doesn't have to be statistically significant, or be something that immediately alters management style; it could be a series of steps (progressive protection?)
 - b. Shane mentioned the importance of needing to collect the data in a statistically significant manner. This is not always been done by the park staff in the past.
2. It was determined that we needed to go through each of the parameters to determine what we wanted to know about each parameter. We went through the list of LABE parameters to compare to our new list (created yesterday) to make certain we did not miss anything.
 - a. Did not capture:
 - i. Amphibian
 - ii. Pika
 - iii. Birds – decided not to include birds because we are already doing bird monitoring in the parks. However, the current monitoring effort does not focus on cave entrances and it was thought we could do an cave entrance inventory. It was suggested that if we do scat counts birds may be picked up in this measure.
 - iv. Reptiles – Felt they were important, occur mainly in the light zone but have been found in the dark zone at LABE but low quantity.
 - v. Carnivores – The question was asked if predation an important component of caves. It was concluded that while predation occurs

in caves, it seems like it is opportunistic, near caves, and at low density.

- vi. Tumble mustard and exotics were considered a threat, but not necessary occurring throughout the parks. The weed can block the entrance of a cave and limit movement of bats. It was suggested we could record presence / absence.
 - vii. Warts and mosses – S. Jessop found them in isolated population in cascades. Did not feel it is something worth monitoring because it is time consuming and hard to identify. Recommended this be more of an inventory project.
 - viii. Air movement – Felt this measure is highly variable by time of day and season. It is hard to measure for our budget. Determined airflow is a high priority for inventory.
 - 1. Shane thought we should scan the literature to see what is being done. Jean mentioned that the literature shows it is difficult to monitoring one cave and then generalize about another cave. Even within one cave measurements can change from one passage to another.
 - ix. Pool levels (change from vertical ice to ice pools) (LBE also have ephemeral liquid pools which vary in time)
 - 1. General consensus rename yesterdays ICE to include all WATER
 - 2. Discussion on whether or not protocols should include pH, nutrients, alkalinity, etc. included in Water Quality protocols for cave creek in ORCA – but this would only be once every three years.
 - x. Infrastructure – Determined it was not appropriate for this protocol
 - xi. Regional effects (burning, soundscape, light glare) – Decided there were not to be included
 - xii. Soundscape and light glare – Decided these were out.
3. John brought up the question about the differences between inventories and monitoring and was wondering if inventories should be included in the protocol. Daniel responded that inventories should be separate from the protocol and that they would not be funded with the monies currently set aside for this protocol. Sean mentioned the use of year end money to complete these inventors.
- a. Daniel mentioned that there may need to be some ground work done on these inventories to help support the monitoring effort because we will need to understand the temporal and spatial variation.
 - b. Jean mentioned that cave monitoring is relatively new and many of the specific covariates we are discussing are not well understood.
 - c. Sean mentioned that we would be conducting a pilot study to test some of this by as Jean pointed out there study would not be long enough to get at a lot of these questions.
 - d. Daniel thought the pilot project might be more about understanding gradients and sampling strata. Use pilot project to understand what controls variation, e.g. elevation with vegetation surveys.

4. There was some discussion on energy flow and how energy is incorporated into the cave ecosystem.
 - a. Daniel wanted to know how VS candidates are associated with the idea of energy flow, predation, food chain, etc.
 - b. Mammals and bird were listed an large contributors to the energy of a cave including inverts and microbes.
5. It was recognized we have a large lists of items and we need to be able to setup some statistically significant sampling design to survey them and it is very likely we will not be able to do this for all the parameters.
 - a. Had a discussion on the potential to collect some information on covariates for the first couple of years. However, Jean pointed out that for a lot of the parameters we listed there is little information on how to monitor them is a sound manner
6. There was several comments that we determined were related to the sampling frame issue.
 - a. Daniel thought we would need to discuss the sampling frame but it was determined that until we figure out which parameters we will study then in would be premature to discuss the sampling frame.
 - b. Shane mentioned that same caves have good maps and some do not.
7. We discussed a few additional parameters that had not been mentioned or were only mentioned briefly in earlier discussions.
 - a. Shane wanted to include condensation monitoring. He felt inversions in the caves are important to bats needing warm and dry areas versus fungi needing cool and wet areas. John mentioned that condensations helps create popcorn areas in ORCA as cool air moves through the caves and warms up. Suggested we use Hobos that monitor CO². Jean mentioned that CO² is a cave specific measure and it is not possible to compare between caves. Could use this in ice or bat caves but more research needs to be done to see what this would get us.
 - b. Elizabeth mentioned that ORCA has a pressure transducer in the cave stream and that they have been monitoring seasonal pool levels. Jean wanted to make sure we all understood that data loggers take a lot of TLC and it is not a simple matter of just setting them out and leaving them. John suggested this be more of an inventory question because they want to know the evaporation rates so they can look at water budget.
 - c. Decided to change the ice parameter to include (water / ice)
 - d. Had a discussion on the potential of creating some index of biological diversity but it was felt this is probably not applicable for this protocol. It is good to keep this in mind as we develop the protocol in case we can put some things together.
 - e. Talked about the O/E ration – observed / expected ration developed by Chuck Hawkins and others.
 - f. Discussed the potential to do predictive model based on various parameters to do a comparison of pristine vs. non-pristine caves. Figured this would take a large sample size which we do not have the funding to

complete. There is also a lack of baseline information available however LABE has inventory forms on ~400 of their caves

- g. Talked about the possibility of conducting scat counts
 - i. This would allow you to have some simple measure of bird and mammal use.
 - ii. Some issues with counting old scat, but there are several ways to deal with this. In addition, Jean pointed out that much of the scat would break down between sample periods.

Day 2 – Afternoon Session

After the discussion of misc. items, we decided to go through each of the parameters we selected for potential monitoring to determine the best methods, sample sizes, and potential issues.

- h. Abiotic Parameters

- i. Climate

- 1. Mainly use data loggers
 - 2. Issue with humidity and condensation on the lens which can have a problem. Can use min / max temp. Can bring hand equipment to test loggers. Checking on the equipment can be a time sink but we need to determine the time needed. Can use a microstation (4-500\$), then you need to buy the sensors so the total cost would be ~1500 each. Wondered if parks could find some money to help establish stations and Dave thought they might be able to. John would want to make sure they measure CO². If we use the microstations we want to make sure there is a standard on how to use them so the data can be compared between parks. Although it is recognized that the placement of the stations may differ between parks.
 - 3. Need to determine the level of inference (caves vs. ice caves vs. all caves) 32 caves with ice, visitation vs. non-visitation caves could be used, but then microstations would be implemented. Variation is higher in caves without ice.
 - 4. Daniel recommended focusing on the ice caves and the caves with bats (~40-50 caves)
 - 5. Jean recommended looking at the sop which will let us know how much we can do and then define the sampling frame from this point.
 - 6. Dave mentioned the parks might have some additional equipment and wanted to know how they could use this equipment to build onto the protocol.
 - 7. ORCA has 10 data loggers with interesting variations in different part of cave. Have seen some pattern changes

based on the location of the cave. Would like to have a few climate stations mentioned above.

8. This was some talk about the number of hobos at each cave and the placement of those hobos within or near the caves but no final opinion prevailed. Jean will look into this as she develops the protocol.
 - a. Moving hobos around in bat caves but keeping constant in ice caves
 - b. Just putting hobos at the entrances
 - c. Using multiple hobos to measure along the gradient of the caves.
 - d. Placement would be dependent on the park. Gradient option in ORCA might work but a distributed model in LABE would be better.

ii. Ice / Water

1. At ORCA you can do direct measure so we do not need equipment in the caves. KLMN will measure water quality parameters once every 3 years and ORCA are currently monitoring the depth and width of pools. ORCA has not done any pools yet, this is their first year of this effort.
2. LABE has fixed points to measure ice and they photograph the ice. Have data from 10 plus years. Doing a baseline of the 15 or so that they have sampled. Their protocol needs to be looked at to see if they are using the best methods possible. LABE will be taking ice cores of the deepest and thickest ice this year. They often rely on volunteers to take the pictures and a more formal protocol may be needed.
3. Shane mentioned the desire for ice cores and they may already have some who is going to do this. He mentioned the possibility of putting in a bar gauge to help with monitoring.

iii. Lint & Dust

1. No one is doing any monitoring right now.
2. In 1984 LABE had a one or two year project.
3. Daniel made the argument that different sampling frame may be needed because you want to look at visitation caves.
4. John suggested this may be an inventory because if we establish the amount of dust and lint we can use visitation as a proxy. Lint is hard to clean so the question is due we need to monitor. Decided to add this to the alternate list.
5. Dave mentioned that it would be hard to know what the management options would be for this. Hard and \$\$\$ to do? Eric thought it sounded like it may be a cheap option to monitoring.
6. Decided to put it on the alternate list.

iv. Soil Chemistry

1. It was determined this would be a hard parameter to monitoring for the limited funding since the below ground soil chemistry is highly dependent on the above ground soil chemistry.

v. Visitation

1. ORCA records every visitor to the cave
2. LABE is using pressure counters (6) and 5 additional counters, and a register system.
3. Daniel wondered if this parameter is a covariable or is it a primary variable. A lot of time needs to be given to sampling design – how would existing visitation sampling frame work with VS?
4. Sensors are 3-400\$ each.
5. Protocol still needs to be written for the work being done at LABE.

vi. Broken Formations

1. Discussed the possibility of monitoring broken formations but decided there is no current practice that works well for our parks since the caves are so wet.
2. ORCA tried but the permanent markings kept wearing off.
3. Daniel thought this was a management issue and may not warrant monitoring. Jean mentioned that it is a geological resource and it is also a non-renewable resource.
4. Dave was supportive of monitoring broken formations but only if a good protocol could be worked out.
5. Decided to place this parameter on the alternate list.

vii. Sedimentation

1. Mentioned that there is a correlation between sedimentation and visitor use so we may not need to concentrate on sedimentation
2. John thought more important than this is the effects of wet substrate on microbial communities. So although sedimentation may not be real practical, Water may be important.
3. Jean brought up the point that in wild or quasi-wild cave, sedimentation may be important for invertebrates.
4. Shane thinks the sedimentation issue is interesting – e.g. “Class 2” caves – see maybe 50 or 60 people a year: still nice floors, substrates, etc. LABE is interested in maintaining these conditions – interested in possible need for flagging system to mark trails, implement a trail system in these caves.
5. Jean brought up the point that maybe all you need to do is monitor visitor use as a surrogate for sedimentation effects?

Shane agreed that sedimentation is event driven and Jean mentioned that it should recover over time.

6. General consensus – Sedimentation/substrate impacts may be important if feasibility issues can be worked out.

- i. Biotic parameters

- i. Amphibians and Birds

1. There was some consensus that we should not do birds or amphibians; however it was noted that several species of birds (owls, martins, swallows) use the cave entrances and provide a sustentative source of energy input into the cave system.

- ii. Plants

1. For vascular species at cave entrances we could id all plants and non-vascular plants we could do % cover. % cover was selected because the skills needed to ID the non-vascular will likely be a limiting factor.
 2. Plant community at cave entrances are important for microclimate issues.
 3. Plant structure is also important for some wildlife species such as pack rats, woodrats, and pika.
 4. It was suggested by Shane that we could limit the monitoring to the fern community since this is a key species at the cave environment that the park is concerned with. It was felt the parks staff has the skill level to do the fern monitoring if it is selected
 5. Some concerns were brought up on how to define the “Cave Entrance Community”. The feasibility of the vegetation effort will depend on how we define the cave entrance. Daniel thought a floristic inventory would be important and probably cost effective.
 6. Shane brought up the point that a diversity measure at the cave entrance might be important if we are looking at changes over time.

- iii. Determined we need to decide if we should do all biotic parameters at each cave or do we split the caves into multiple sampling frames. It was recommended that most parameters are easy to measure so we might want to do them at all caves.

1. Jean thought we would be doing at least some of them at all caves.
 2. The idea of a checklist to be filled out at the cave entrance was brought up. This could include information on many of the biotic components.

- iv. Try to look at the caves and come up with a holistic approach to monitoring for biotic parameters.

v. Discussed measuring a gradient at ORCA along cave route and perpendicular to the cave route.

1. Daniel mentioned that this sort of design would need a conceptual model for the protocol.

vi. Bats

1. Currently the LABE Bat project consist of 1 visit in hibernacula per year / 2 people. There are 40 to 50 caves being used as a hibernacula and the park has 20 as a priority per year.
2. In summer – 3 groups try to track Townsends by getting 2 good outfight counts (go out 18 to get the best 2 counts), biggest effort in the cave loop. 20 caves, 2 people per night, ORCA do critter counts along the trail and misc studies.
3. Consensus that we should continue the bat monitoring efforts. Although we may need a completely new sampling frame for bat monitoring?
4. There were a variety of questions about the current methods the parks are using the would need to be answered to make a strong protocol. Some of these included:
 - a. Is the current bat monitoring a pet project or is it truly important to the park.
 - b. Do the counts need to be done every year, multiple times a year, and every 5 years? What is the replication process that is most efficient and accurate?
 - c. Which species do we focus on, all 13 or Townsend and Free-tailed bats?
 - d. What is the best method to get an accurate price is the method affordable?
5. Jean though one of the goals should be to write up what the parks are currently doing, make it more robust and then transfer it to an SOP for the protocol. Jason mentioned that the parks would be willing to switch to a different method if it made sense to do so.
6. Daniel mentioned that the SOPs and narrative must keep focusing on *why*? Why bats. Needs to be made into defensible VS. Should it be specific bat species? Jean thought this should be easy to do. Example: Easily affected by climate change, 1 species is at their northernmost range. Bats are important to cave (pull energy from outside to the interior of the cave). And maybe certain bat species are not in protocols for LABE (focus on specific species). Daniel agreed and mentioned 2 things then about bats: 1) Standard importance (e.g. conservation, climate change, etc.); but

also 2) Ties into other biota, and the community structure of the cave

7. Jean thought that the situation for a random sample may not be necessary because caves are so different; it makes it hard to detect trends. Daniel stated that there will be a strong expectation from peer reviewers that there is a probabilistic sample scheme. Maybe incorporate sampling strata (e.g. only caves longer than 1000 ft deep). Biggest caves would probably encompass most regional biodiversity. So maybe: within 1 km of road, at least 500 ft. long.
8. Need for 1 statement: 1 sampling frame that encompasses all, *or* 3 judgment cave for ice, 3 judgment caves for bats, probabilistic for rest of biota. (3 is an arbitrary no. – could be something else too.)
9. ORCA is interested in Anabat info and methodologies too. Larson pointed out that there is a time issue when it comes to analyzing the data. In addition to the need to train individuals.

10.

vii. Rodents

1. Felt there was the potential to reduce caves # by selecting caves with the highest probably of diversity (large caves).
2. Labe had these as a high ranking parameter but they have not done any surveys at this point in time.
3. Determined that the amount of work being done to survey rodents will depend on the method selected. Trapping versus scat or bedding material are very different in the time it takes to complete this methods.
4. Dave pointed out that rodent populations are highly variable at the cave entrance and he has seen some caves with large numbers of rodents and other similar caves with little to no sign of rodents.
5. John mentioned using scat counts to monitoring. Hyphomycetes only grows on new scat so you could tell the difference between years for woodrats.
6. Daniel wondered if caves are a critical element for woodrats such as they are for bats. Shane mentioned there is a long history of woodrats using caves and have even been found in the dark zone. Jean also mentioned they woodrats are a main source of energy input for the cave environment.
7. Sean mentioned that mammoth caves already has a woodrat protocol and we could look at theirs to see if we can use the same methods.
8. There was some discussion on using a stratified approach.

- a. Ice caves separate, then all others for biota (over 300 meters long...)
- b. Stratify on elevation
- c. Length and depth for most caves

viii. Invertebrates

1. Jean mentioned that their distribution is clustered; sampling is hard, dependent on islands of productivity. Hence, invert monitoring in caves is often a “list activity” and is not a quantitative measure. Attractants only work somewhat. Standard method is usually to run through cave, recording observations.
2. Daniel wondered about timed searches and Jean thought those have very high observer bias issues. But they should be considered, probably combine with other techniques, and it can be done non-destructively.
3. Jean mentioned that FWS has “valid, vetted” protocols, but still has issues (like low detection).
4. Dave wondered what the relationship between invertebrates and management would be. Jean thought management would be more concerned with bats and rats and that if invertebrates was a high priority then a lot more effort would be needed to develop this portion of the protocol.
5. It was decided that we could put this on the backburner and perhaps do inverts in more of an inventory capacity in the future.

ix. Microbes

1. John recommended surveying microbes because he would use the data to help with carbon budget issues, and it could integrate biotic with geological aspects. A case should be made for BOD (Biological Oxygen Demand). Do it next to trail, away from trail. Establish a baseline. Lots of information to be gained. Interesting patterns. Abundant, easy to get results.
 2. Daniel wanted to know how you would characterize in a sampling design but John thought this could be looked at later by Jean and her staff.
 3. Eric discussed BOD as biological oxygen demand. In aquatic situations, it is usually done by enclosing water in a special container, and monitoring the amount of oxygen consumption or production over a time period.
 4. Daniel stressed the need for confidence levels to be placed on the data.
8. We had a short discussion on the cave categories and some possible ways we could divide them up to limit sampling frame.
- a. Long caves (High diversity). (LAGE - caves at a mile long, 15 caves @ 1000m)

- b. Bats vs. non-bat caves (40-50 caves)
 - c. Accessibility – many of the back country caves are small and our sampling efforts would create a disturbance that could affect any monitoring we might employ
 - d. Visitation vs. non-use or low use caves
 - e. Ice vs. non-ice
9. We talked about the potential of a split design with multiple judgment sites depending on ice and bats.
- a. Daniel questioned if we need to dedicate the same amount of time at each cave. The consensus was no.
 - b. Thought some SOPs would be done at 1 park and some at the other. However, several SOPs could be implemented at both parks.
 - c. The main goal is to meet the objectives.
10. For the Future
- a. Maybe over the phone; Daniel would like another meeting – still need talking about objectives, power, etc.
 - b. Maybe Jean could come back with alternative choices figured out? After February?
 - c. Maybe have a field trip thrown in? Jean thought this is why you do a pilot project?
 - d. Sean mentioned the first draft will have a lot of work in refining – so base pilot study on 2nd draft.
 - e. Last thing: meeting in Denver in November? Daniel is planning on attending; Elizabeth will be there for ORCA.